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AN ENGLISHMAN'S VIEWS OF THE PANAMA CANAL.

BY ARCHIBALD R. COLQUHOUN.

AMONG the relics of vanished civilizations there are many remains of engineering works which would have been monumental in any age, but which appear stupendous as the achievements of people who had not that great servant the electric current at their beck and call. I sometimes wonder whether any one of these was discussed, debated and experimentalized upon as the Panama Canal has been! To the casual observer—that most inaccurate person—it must seem extraordinary that apparently so small a feat as the cutting of a neck of land only some forty miles wide should present difficulties which have kept the united wisdom of the ages at bay ever since Nuñez de Balboa, in 1513, first sighted the Pacific and stimulated the search for the new highway to the East.

It is not likely that I should attempt to minimize these difficulties, for, on my first visit to the Isthmus, in 1895, to report on the rival routes for the canal, I was so strongly persuaded of the engineering obstacles of the Panama route (as now chosen) that I strongly urged the adoption of the Nicaragua line as more feasible, though longer and less convenient. Since that time, however, engineering has made great strides, and the political conditions, which then appeared to me unfavorable, have been entirely changed. The Panama route has also by the work of the last four years been robbed of one of its main disadvantages—the deadly character of the climate. In 1895, the investigations of science into the cause of malarial and other tropical fevers were still elementary; and, although here and there a pioneer was trying to get a hearing for his theories, no government had yet thought of attempting, as the United States has since done,

the great task of cleansing tropical regions of the disease-producing germs.

The last twelve years of history in the engineering and scientific world have brought us nearer to the solution of the Panama Canal problem than the centuries (close on four) which have passed since Bastidas, "Spain's best and noblest *conquistador*," first sighted the shores of the great American isthmus in 1501. The United States, which have overcome two of the greatest difficulties, in securing unquestioned political control and in rendering the canal zone habitable, may well congratulate themselves on possessing the keys to success. I believe in their work and their destiny as the builder of a canal, and it is therefore in no carping spirit that I now indicate some of the chief obstacles which they have still to overcome.

It is obvious to careful readers of the copious literature dealing with the question of canal construction in the last few months, that so far neither the type of canal nor the principle of construction is as yet definitely settled. American readers are so familiar with the discussion as to "sea-levels" and "locks" that they must forgive me for briefly reiterating, for the sake of clearness, the projects hitherto considered.

Three types of canal were chiefly discussed. The first—a sea-level, with a great flood-regulating dam and sluices at Gamboa, and with two tide-regulating locks at the Pacific end in order to obviate the tidal range of nineteen feet, at an approximate cost of £50,000,000—was chosen by the majority of eight members (three Americans and five Europeans) of the International Consulting Board, which was a body composed of the first engineers of Europe and America. It was in their opinion the only project "giving reasonable assurance of safe and uninterrupted navigation." The second project, ultimately adopted by the United States Government, received the adherence of a minority of the Commission (five in number) consisting entirely of American engineers. It provided for a "lock and lake" canal, with an immense artificial lake, at a level of eighty-five feet above the sea, to be held up by a great dam at Gatun, on the Chagres River, some three miles from the Atlantic in Limon Bay. This scheme, which was estimated to cost £28,000,000, is in all essentials no new plan, but is almost identical with that of Godin de Lépinay, the distinguished French engineer, in 1879, who, however, pro-

vided an alternative site for the dam at Bohio in case Gatun should be found unsuitable. A third project, a lock canal of the usual type, recommended by the majority of the Board of Consulting Engineers in case the American Government decided to build a lock canal, provided for a height of not more than sixty feet, with a regulating lake and dam at Gamboa, and was estimated to cost £35,000,000. This scheme, which had the advantage of being so designed as to be convertible into a sea-level canal, was not adopted by the United States Government, which, for reasons "other than of an engineering character," preferred the "lock and lake" project already referred to.

Nevertheless, the weight of expert evidence in Europe and the United States has been so heavily in favor of a sea-level scheme that there was actually a majority in its favor both in the Senate and the House. In the last few months, opinion has been swinging round in the direction indicated by Senator Knox, at the time when the type of canal was decided by Congress, when he declared that, though not the type immediately chosen, the sea-level canal should be the ultimate aim. It is the conviction, founded on the opinions of all the first engineers of the day, that the only permanent and satisfactory highway from Atlantic to Pacific must be as nearly as possible freed from artificial works and the dangers consequent on them, which makes me regret that the United States should have adopted the "lake and lock" scheme. As I shall show, it involves works which will directly impede the ultimate sea-level channel, even if they are in themselves practicable—which is extremely doubtful.

The idea of many people seems to be that the Culebra cut—the divide between Atlantic and Pacific—is the greatest difficulty to be met; and the encouraging reports of the excavation done there by the great steam shovels has even led such journals as the London "Times" to the conclusion that another seven years may see ships like the "Mauretania" steaming through from the Caribbean to the Pacific. But, although the cutting of the Culebra cut is a stupendous work, and one that seemed to me twelve years ago almost impracticable, yet it is to-day merely a matter of time and money. And, although the figures now being supplied are not trustworthy guides as to the necessary expenditure under both these heads, since it is no mere question of straightforward "digging," yet there is no ground to doubt that

the problem of the Culebra cut is on the road to solution. The work now proceeding there has this advantage—it is necessary for any scheme and can be pushed on without regard to the rest of the canal. Not so the operations for overcoming the other great difficulty, the Chagres River. Now, as in 1895, this is the key to the situation—*la grande inconnue*—the unknown quantity, the small stream which, draining three-fourths of the isthmus, suddenly becomes a tearing yellow flood. On the Pacific side, the rivers are insignificant and can flow partly direct into the canal and partly into the Rio Grande. Engineers with life-long experience of tropical regions find it difficult to calculate the exact strength necessary to control such erratic floods; but it is agreed that a colossal dam and regulating lake are necessary at some stage of its career to regulate the Chagres, since the canal will pass along its channel and cannot safely be subjected to sudden and violent floods.

The “lock and lake” scheme now under construction attempts to meet the difficulty by a huge earthen dam at Gatun. By means of this the Chagres would be spread out, during the greater part of its course, into a huge lake (about thirty-two miles in length and reaching to within a few miles of the Pacific) at an elevation of eighty-five feet above sea-level. From this lake a giant flight of locks would descend on either side to the ocean level. The Gatun dam would extend for 7,700 feet on the crest; its foundations, as is admitted by its projectors, would be on earth and other uncertain and unreliable materials, since the rocky foundation of the subsoil is from 260 feet to 300 feet below the surface at the site. This great dam, made of earth (protected on the up-stream slope by a rock wall), without core, stop wall or cut off, is the key to the “lock and lake” scheme. On it depends the success of the whole project. No change of detail in its construction, nor slight variation in its position, can alter its essential character. It was modelled originally on the Wachusett North Dyke (near Clinton, Mass.), completed in 1905. This dam partially collapsed in April, 1907, when subjected to a much less pressure of water than it was designed to hold, and about two-fifths of that which the Gatun dam may have to bear. Since then—and even prior to the disaster—there has been a doubtful note, even in the opinion of the most optimistic, with regard to the Gatun dam.

The giant locks are a second drawback, for it is obviously no small undertaking to raise and lower vessels like modern battle-ships, of 22,000 tons, (and notoriously unwieldy even in the most favorable circumstances), or liners like the "Mauretania" with eighty-eight feet beam, up and down this Brobdignagian staircase. It may be mentioned, in passing, that in the estimates for the "lake and lock" canal the size of lock necessary was underrated. The essential increase, and the compensation (not allowed for) for the huge area to be submerged, beyond the canal zone already belonging to the United States, would bring the cost up to nearer thirty-six millions than the twenty-eight now estimated.

The alternative plan for damming and controlling the Chagres adopted in the sea-level scheme, and one which is considered by the majority of experts as essential to any sea-level scheme, is also embodied in the lock canal projected by the majority of the consulting engineers under a reservation already noted. In the sea-level scheme the Chagres is taken at an earlier stage in its career before the canal enters its bed, at the point where it turns eastwards to the Atlantic. Here, at Gamboa, its head waters are confined by a dam, which converts them into a lake reservoir provided with numerous spillways and sluices. The site is claimed to be ideal, providing a rock foundation and near to the Culebra cut, so that the rocky excavation can be utilized. The dam would have a core wall of concrete, supported with earthen walls and faced with rock. Its height would be 135 feet, its crest 5,000 feet long, and it is believed that it would be adequate to domesticate and control the river at this point and to ensure the regularity of the velocity in the canal. The Gamboa dam has this advantage over the Gatun one—it is equally practicable for a lock or sea-level canal, and is in the opinion of the majority of engineers an essential feature of either. It is a fact, ignored or forgotten in the United States, that this Gamboa dam, or a dam on an alternative site higher up the Chagres valley, has formed a feature in all canal schemes since that of de Lépinay was rejected some thirty years ago. No sufficient reason, so far as I have been able to discover, has been advanced for abandoning Gamboa in favor of Gatun; but the impression seems to have prevailed in certain quarters that a comparatively inexpensive and easily constructed earthwork at Gatun would suffice, and would provide a good lake waterway at a high level, thus minimizing

excavation. The ingenious theory was attractive to those who desired, for political reasons, the early opening of the canal. But it depended for its success on premises which were insufficiently proved.

The administrative difficulties which have met the United States Government are, like the Culebra cut, mostly a matter of money and patience, but the work has been complicated in a manner little anticipated when it was first undertaken. One chief engineer after another has thrown up the task, and numerous commissioners (many with no previous experience) have succeeded each other, to the detriment of any continuity in the policy of administration. The invitation to contractors was not responded to by responsible firms, since the conditions were considered by them to be too complicated and onerous. Since March, 1907, the Canal Commission is actually on the isthmus and in direct touch, and the whole working has been handed over to the military authorities, a course which is less unusual in the United States, where many public works are done by the military engineer, than it would be in Great Britain. In our Indian empire, of course, the Royal Engineers do similar work under similar conditions. The great advantage in Panama will be to secure permanence in the personnel, since army engineers under orders cannot be tempted by more lucrative employment elsewhere or influenced by family considerations. The present chief engineer, Colonel Goethals, who has the immense advantage of being also Chairman of the Commission, has the reputation of being a man of iron determination and discipline, and under his eye matters certainly seem to be proceeding with a regularity which has been lacking hitherto.

The question of labor supply is one which will make itself felt more keenly as time goes on. At present twenty-seven per cent. of those employed are white and Eurasian, and the health conditions as secured by the great exertions of the United States render it possible for them to live and work on the isthmus, although the preservation of those conditions and the arrangements for their comfort render their employment a very expensive luxury. But I am much inclined to doubt whether even freedom from malaria can render work at Panama really healthy for white men, as is claimed; and I am convinced that the supply will need to be constantly replenished. The same applies in even greater

measure to the colored labor supply. It is little understood that pulmonary complaints are more fatal to colored laborers than fevers, when working in the tropics. The frequency with which a man sits down to eat, or goes back from work, in a wringing wet condition very soon tells on the constitution. If reports from Panama can be trusted, a great deal more needs to be done both for white and colored labor to minimize a danger which is quite as real as malarial fever.

The source of the colored labor supply, so far, is chiefly the West Indies, and this cannot be indefinitely exploited, since already there is a shortage of labor in some of the islands. Asia, of course, could supply an unlimited number, but the present relations between Asia and America do not encourage a hope that this reservoir can be tapped. Panama itself is now bitterly anti-Asiatic. It will be especially interesting to watch how this problem of labor works out on the canal, because the conditions are to a certain extent novel. Great engineering feats in ancient times were executed by slaves. In more recent days, contract labor was employed under conditions which gave those responsible complete authority. To-day, we find a democratic government for the first time engaged in a vast engineering undertaking outside the boundaries of its own country. To a certain extent, the theories as to the construction of the canal by free labor have already broken down, since it has been necessary to place the whole work under military control. Even under these conditions the problems raised by modern ideas of the relations between employers and employed, and the claims of the latter to regulate those relations, will inevitably complicate the administration of Panama, and must be an important and ungauged factor in determining the length of time necessary for the completion of the work, as well as the expenditure involved.

One criticism presents itself very forcibly to the Englishman with some knowledge of engineering work in other parts of the world. It has not seemed possible or desirable to the United States Government to place the work (as would be done anywhere else) in the hands of one man, who would be subjected to no ulterior influences, and make him responsible for its speedy and economical completion. The United States, except in rare cases, prefers to deal through commissions, although practical experience has demonstrated the disadvantages of this system.

At the present time there is a Canal Commission which is the supreme authority on the isthmus, and of which Colonel Goethals is the Chairman. To my mind, the efficiency and success of the Commission largely depend upon the extent to which Colonel Goethals, or some other man of strong personality, can succeed in dominating the rest of the commissioners. In other words, multiple control is as futile in engineering as in war operations. The United States Government is the controlling force, dictates the policy and provides the funds; but for the instrument to carry out their wishes they do not need a multiple-headed executive, but one good man, with complete power and responsibility.

The political aspect of the canal is, perhaps, the one which has undergone most changes in the last twelve years. It has improved in some aspects, but in others unexpected difficulties are now looming on the horizon. The centre of gravity has shifted. In 1895 it was European opposition and local difficulties which had to be faced. The first was removed by the negotiations which culminated in the Hay-Pauncefote treaty. No European Power would now dream of making the slightest objection to the control by the United States of a waterway which they have the sole right to construct. The French claims have been successfully eliminated. By the *coup d'état* of 1903 President Roosevelt disposed of an even greater difficulty, which would have been a permanent source of weakness had the canal been made through a foreign state. The alarm excited in South America by this sudden advance towards her boundaries seems to have been allayed; and, though I am far from believing that the southern expansion of the United States will always be as peaceful and easy as the acquisition of the canal zone, yet there is no doubt that she is mistress of the situation and that the Central-American States are aware that their present independence can only be preserved by a correct attitude.

But, if all these conditions are now favorable, there still remains that cloud on the horizon. I shall indicate it very slightly. We are accustomed to speak of the canal opening the way from East to West, from the Eastern States (and even Europe) to the Pacific. We must remember, however, that the tide of traffic may flow equally in the contrary direction, and that the awakening of China and the industrial, as well as the maritime, expansion of Japan are two factors in the case. East and West

will inevitably be brought into more intimate relations, and, considering the difficulty at present experienced in adjusting our intercourse with Eastern Asia, it is not difficult to foresee possible complications of an epoch-making character.

Finally, I must return for a moment to the canal itself. Many prophets there be who, assuming a certain progressive increase in the amount of monthly excavation at Culebra, arrive at a conclusion and tell you the exact date at which the Atlantic and Pacific will join hands. I am not one of those because I have yet to see the adoption of a scheme for controlling the Chagres which has some reasonable chance of success. I am indebted to engineering experts of European reputation—who I believe are confirmed by those of America—for the following estimate, which I offer to my readers with all possible reservations as to the effect of seismic disturbances, unusual floods or administrative difficulties. If the work which is said to be now proceeding at Gatun were abandoned, and all energy were concentrated in damming the Chagres at Gamboa, and excavation were vigorously pressed, a sea-level canal might be opened in ten years from the present time. A lock canal with dam at Gamboa might possibly take less time—though this is doubtful; but whether it is worth while to construct expensive temporary works just to save a year or two and to lessen the initial outlay is a controversial point. From an English point of view, it seems entirely false economy. Lastly, the works at present proceeding, which are expected to open a “lock and lake” canal in about seven years’ time, at a cost of £28,000,000, will, if persisted in, put the canal back several years. To base any scheme on a work like the Gatun dam, which (even in December, 1906) the optimistic President considered to “involve some risk,” is to build a house on sand. I have no doubt that the scheme will be ultimately abandoned in favor of one which has the sanction of the majority of engineering experts; and the pity is that the change of policy should be delayed to the great detriment of a work of international importance.

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